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STATE OF TENNESSEE
STATE GEOLOGICAL SURVEY

GEO. H. ASHLEY, STATE GEOLOGIST

BULLETIN 13

A BRIEF SUMMARY OF

RESOURCES OF TENNESSEE

FOR THE HUNTER, MINER, SEEKER, INVESTOR, BUSINESS MAN,
FARMER AND OTHERS

By Geo. H. Ashley, State Geologist.



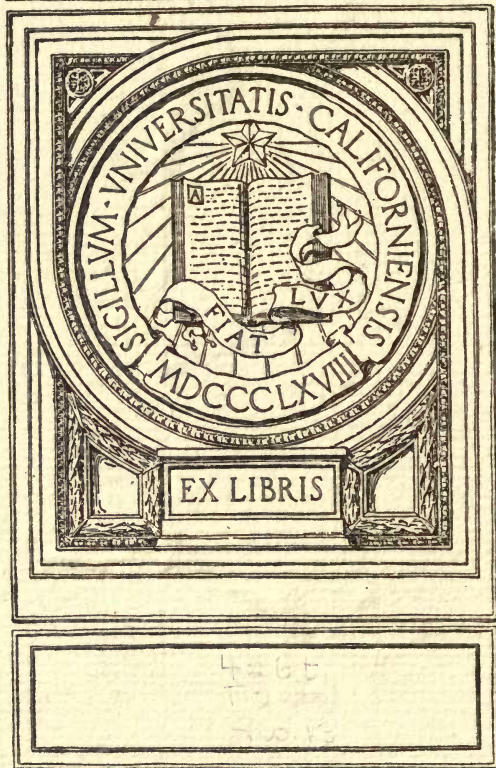
NASHVILLE, TENNESSEE

1911

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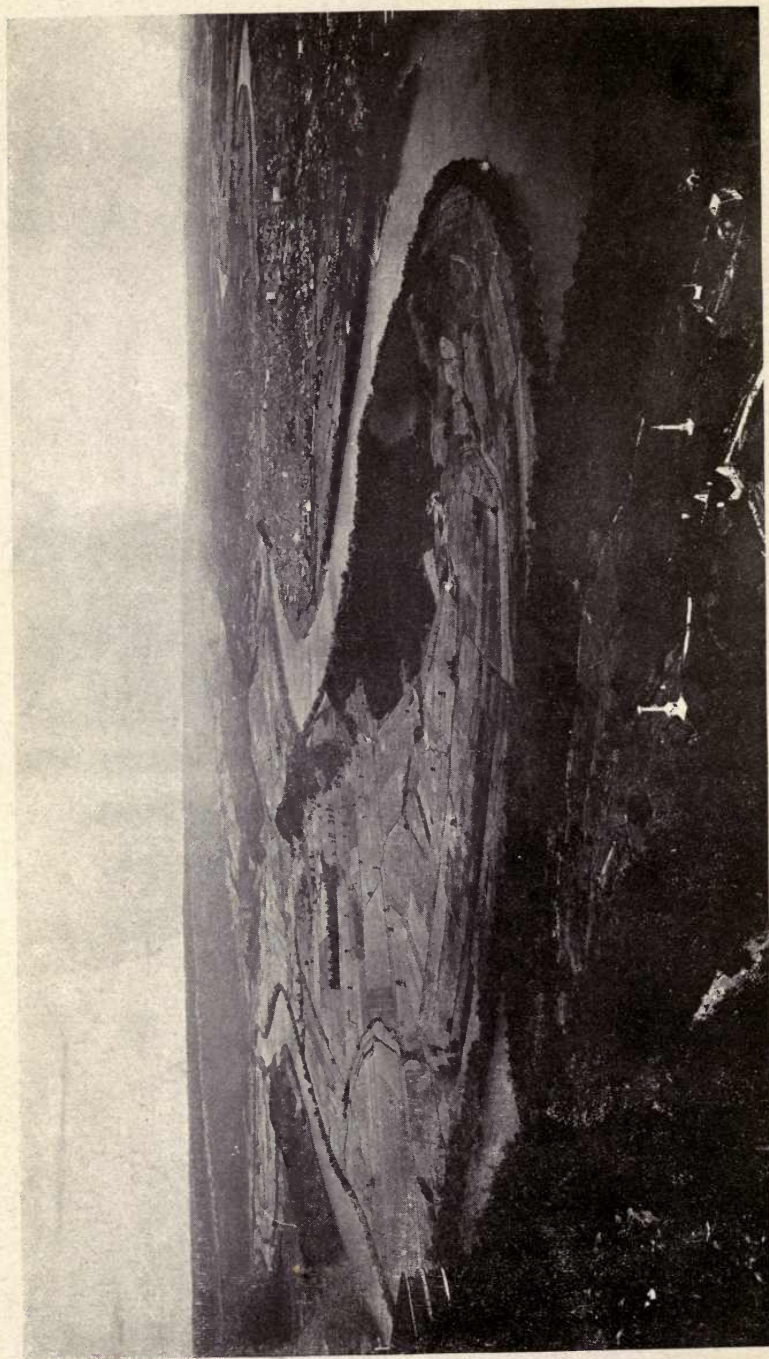




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TO THE
MOUNTAIN



MOCCASIN BEND IN TENNESSEE RIVER FROM MT. LOOKOUT.
A view that suggests History, Commerce, Agriculture and Industry.

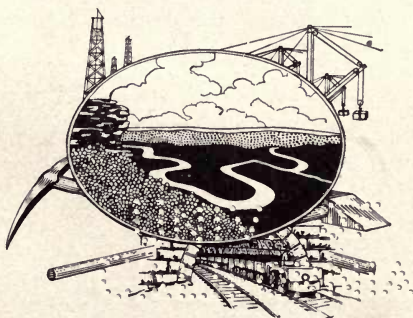
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FOR THE HOMESEAKER, INVESTOR, BUSINESS MAN,
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NASHVILLE, TENNESSEE

1911

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STATE CAPITOL, NASHVILLE.

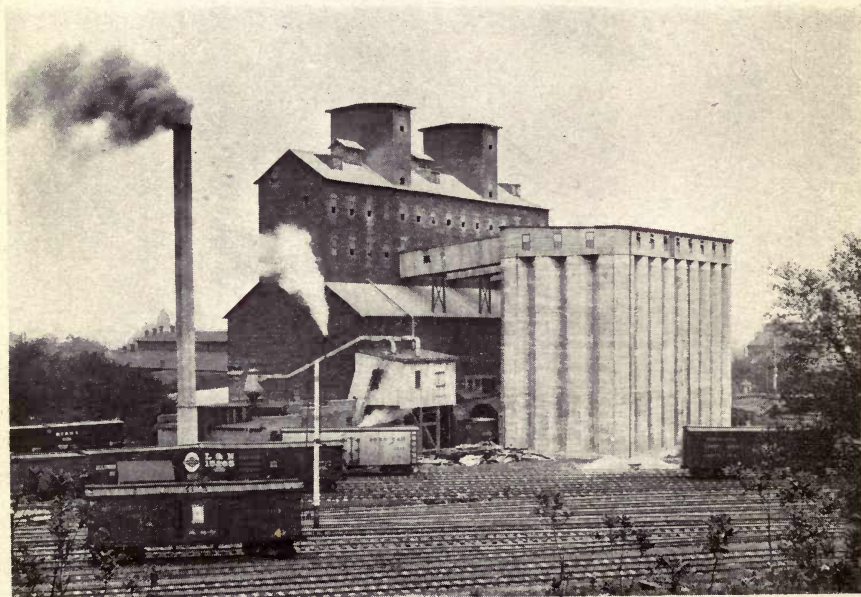
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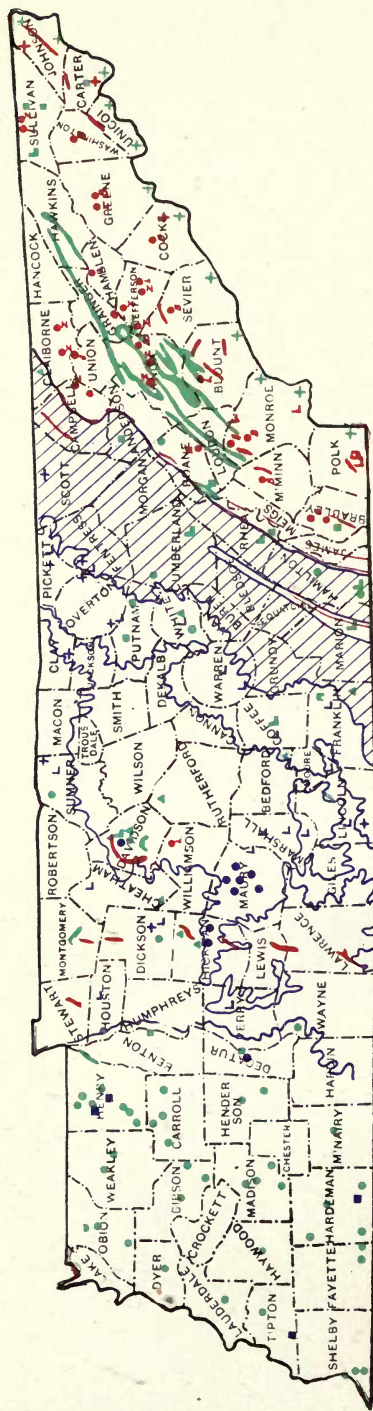
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










NASHVILLE IS GREATEST GRAIN CENTER IN THE SOUTH.

1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810

PRELIMINARY MAP OF ECONOMIC DEPOSITS OF TENNESSEE



LEGEND

- | | | | |
|---|---|---|-------------------------|
|  | COAL MEASURES |  | IRON ORES |
|  | OUTCROP OF BLACK SHALE
BLUE AND KIDNEY PHOSPHATE |  | LEAD, ZINC AND BARYTES |
|  | PEAT. |  | COPPER. |
|  | OIL. |  | GOLD. |
|  | GAS. |  | MANGANESE. |
| | PHOSPHATE. | | |
| | |  | CLAY |
| | |  | SANDSTONE AND SILICA |
| | |  | LIMESTONE AND DOLOMITE. |
| | |  | MARBLE. |
| | |  | GRANITE. |
| | |  | CEMENT AND LIME. |

THE RESOURCES OF TENNESSEE

BY GEO. H. ASHLEY.

INTRODUCTION

With the opening of the Panama Canal in 1913, there will be offered to the Southern States a gateway to the Pacific coast of both North and South America, and to all of the Orient, through which they will have decided advantages over their more distant neighbors to the north. Aside, therefore, from the phenomenal growth that these states have had during the last few years, they seem to be on the threshold of a still greater opportunity.

The wide-awake manufacturers, miners, and capitalists all over the country are alive to this opportunity, and they, as well as farmers and mechanics, are looking to the South for chances for investment and work.

This short bulletin is intended to present in a few words a clear, reliable statement of the State's resources—mineral, agricultural and forest, and in addition a picture of the State's character as a place to live and grow up in, both in the city and the country. The pictures show the character of the country, give some idea of city improvements and illustrate some of the more typical industries. For fuller information, the reader is referred to the list of Survey publications at the back of this bulletin.



RIVER TRANSPORTATION, NASHVILLE.

GENERAL STATEMENT



Tennessee probably equals or excels any other State in the Union in general attractiveness of physiographic aspect, combined with rich agricultural resources and stores of mineral wealth. Much of the State is underlain with fertile limestone soils, associated with a rolling topography, clear, rapid streams and excellent health conditions. Of its 42,050 square miles, probably 2,500 are bottomlands, in part needing draining to become productive; as much more are mountains and escarpment, rising 1,000 to 5,500 feet above the neighboring valleys, picturesque, rich in minerals, the seat of permanent forests; 9,200 square miles are an open valley, 1,000 feet above sea level, a continuation of the fertile Valley of Virginia and Lebanon Valley of Pennsylvania; 14,000 square miles are plateaux, in part 2,000 feet above sea, underlain with coal and iron, and in part 1,000 feet above sea, underlain with building stone, phosphate and other minerals, and both probably destined as great fruit districts; 5,400 square miles are included in the Nashville Basin, beautifully rolling



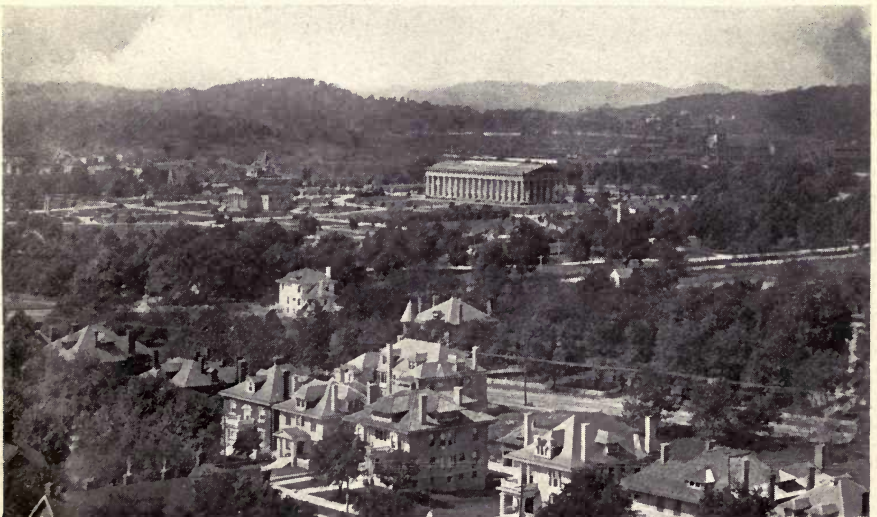
CHATTANOOGA IS AN IRON AND COAL CENTER.



WATER-POWER IN TENNESSEE. HALE'S BAR (Lock and Dam under construction).

and fertile; and 8,850 square miles in West Tennessee are rolling uplands resembling the less level parts of Illinois and adjoining States.

Some idea of the richness and variety of her mineral resources may be gained from the statement that Tennessee, if cut off from communication with all other States, could continue to supply herself with all, or nearly all, of the needful materials to maintain her present or future civilization. Water-power and coal would supply her with power; her mines of iron, lead, zinc, copper, gold, silver, aluminum and other mines would supply her with metals; her building stones, marbles, clays,



RESIDENCES AND PARK IN TENNESSEE CITY (Nashville).

cement materials and forests would supply her with building materials; most of the materials used in chemistry and the arts, she could secure from her own storehouse, if cut off from outside supplies; and with the exception of tropical fruits, she can raise any food raised anywhere in the United States.



RIVER TRANSPORTATION AT MEMPHIS.

Tennessee combines a southern position with high altitude, rendering the climate one of the most equable and delightful of any State in the Union—the winters are short and the summers long, but neither the winter cold nor the summer heat is as great as in the Northern States. The average rainfall is about 52 inches, well distributed all through the year, with an average of 265 clear days in a year. The growing season, as measured by the number of days between frosts, is 189.



TENNESSEE RIVER FROM KNOXVILLE COUNTRY CLUB, UNAKA MOUNTAINS IN DISTANCE.

Transportation in Tennessee is greatly aided by the existence of 1,200 miles of navigable streams, including 315 miles on the Cumberland River, 320 on the Tennessee and 200 on the Mississippi. These insure low freight rates at a large number of points. In addition there are at present almost 4,000 miles of railway track in the State.



COUNTY COURT HOUSE, SHELBY COUNTY (Memphis).
(Copyright by Coovert, Memphis.)

Tennessee has a population of 2,184,612, of which between one-fourth and one-third are colored. The State has four large thriving cities: Memphis, said to be the largest inland cotton market in the United States, if not in the world, and the largest hardwood market in the world; Nashville, the capital, is the largest publishing city in the United States outside of New York, and the leading educational center of the South, with over 10,000 visiting students; Chattanooga is a great iron and coal center and Knoxville, the site of the State University, is the distributing point for much of East Tennessee's mineral and agricultural wealth. These, with scores of smaller cities, compare favorably with other cities of their size any where in the United States—in municipal improvement,—parks, streets, public buildings, etc.—and in the character and appearance of their homes. Illustrations are given of the Shelby County Court House at Memphis, costing \$1,500,000, and public buildings at Chattanooga, public parks at Nashville and Memphis, of business streets in Chattanooga and Knoxville, and of a residence section in Nashville. These pictures give but a faint glimpse into city life in Tennessee.



SUBURBAN HOMES (Nashville).



PUBLIC BUILDINGS (Chattanooga).

Some of the views give a good idea of conditions of life in the country where good roads, rural free delivery and interurban transportation make life attractive here as elsewhere. Life in the small area of the mountains is still primitive, but this is beginning to give way before the fruit raiser. It is unfortunate for the State that this remnant of primitive life has so long proved fascinating to the writer and novelist, as too often to those living away, the name of the State brings up the familiar character of the mountaineer, rather than the prosaic man of affairs, who after all is the man of destiny in the growing State of Tennessee.

The taxable wealth of Tennessee in 1910 is given at over half a billion dollars, with a debt of \$11,500,000. In 1910 the State's income from all sources was over \$3,700,000, the tax rate was 35 cents on \$100. County taxes vary with the county. Between 1900 and 1910 the State Legislature authorized the different counties to bond themselves to the extent of \$10,000,000 for the building of good roads, and some of the wealthier counties have hundreds of miles of good roads built without bonding.



CITY LIFE IN TENNESSEE (Memphis).
(Copyright by Coover, Memphis.)



COUNTRY LIFE IN TENNESSEE IS ALSO ATTRACTIVE.
(Glenclyff Farm, Davidson County.)



TYPICAL TURNPIKE, DAVIDSON COUNTY.

Taken April 15, when unimproved roads were at their worst.

THE NON-MINERAL RESOURCES

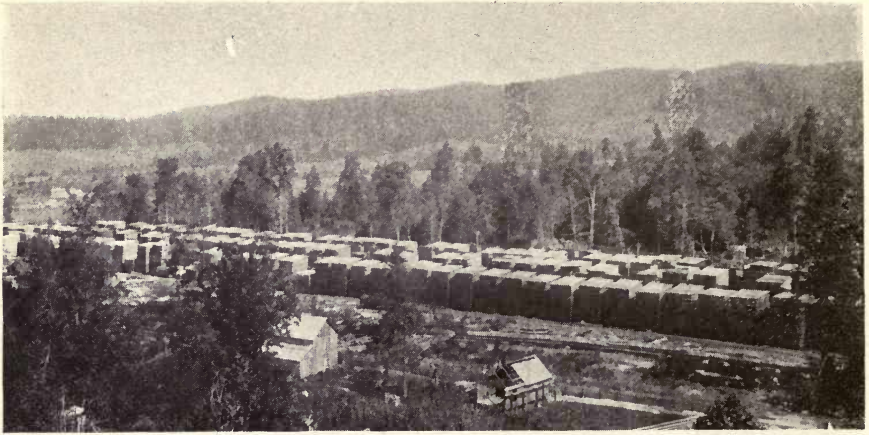
For the purpose of this bulletin, the physiography, soils, forests and other non-mineral resources may be discussed by sections of the State, going from east to west.



OAK TIMBER, UNAKA SECTION, POLK COUNTY, TENN.

The Unakas.—This is the western flank and foot hill region of the Unakas or Great Smoky Mountains, a belt averaging 13 miles wide with an extent of 2,000 square miles and located on the extreme eastern edge of the State. Its general elevation varies from 1,500 to 5,000 feet, with some of the higher peaks reaching over 6,000 feet above sea level. It is a region of often rounded crests suited for grazing, steep, timber covered slopes, and deep gorge-like ravines, opening out onto inclosed valleys, a region of fine timber, great water-power and abundant grazing grounds. Taken as a whole, the soils are coarse, gravelly, thin and unpro-

ductive, though the valleys and coves and some other areas have fairly good argillaceous soils. The country is drained westerly by swift mountain streams tributary to the Tennessee, some of which cut through the range. Small farms occur along the streams and in the broader coves, but much of the region is in large holdings. Most of the land is too steep for cultivation. Four railroads cross the area, besides several logging railroads, but there are portions of the high ridges still very inaccessible and covered with virgin timber—yellow poplar, hemlock, chestnut and a great variety of valuable hardwoods. This region is the source of the copper, gold, silver, slate and granite of the State, and of great deposits of iron. Of these the granite, slate and iron are largely awaiting development. This is "The land of the sky" destined to become a great health and summer resort. Already fine roads are being built to render accessible its beauties.

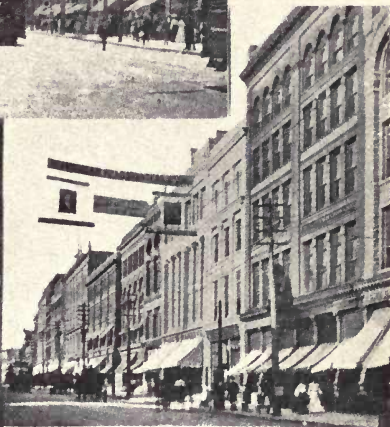


AN EAST TENNESSEE LUMBER YARD (Crandall, Tennessee).

Valley of East Tennessee.—West of the Unaka range lies the Valley of East Tennessee with an average width of about 50 miles, an elevation of 1,000 feet above the sea, and an area of 9,200 square miles. It is a region of long northeast-southwest limestone and shale valleys separated by narrow saw-toothed ridges of sandstone and chert. The soil on the ridges is usually thin and poor, though in places there is a sandy loam that is fertile and well adapted to fruit and garden products. Parts of the valleys over certain rock formations are productive, when first cleared, but deteriorate rapidly if continuously cropped. They do much better when used for grazing and meadows. As a rule the limestone valleys, making up most of the Great Valley, contain heavy soils or loams, and



TYPICAL VIEW ACROSS VALLEY (NEAR JONESBORO), UNAKAS IN DISTANCE.



KNOXVILLE STREETS.

are strong, fertile and durable, suitable for the raising of all crops. The entire region is drained southwestward by the Tennessee River and its tributaries. Several trunk lines of railroads traverse the valley from end to end. Most of the land is held in farms of moderate size, agriculture being the chief industry. Small amounts of second growth timber occur on the crests and steeper slopes of the ridges, and many of the broad ridge tops, as well as the valleys, are in cultivation. The great valley is the seat of the State's marble industry and the source of barytes, zinc, red fossil iron ore, silica rock, cement and many other economic products. The zinc ores are awaiting capital for their development, many of the marbles are lying untouched. There is a fine local market for cement, etc., etc.

Cumberland Plateau.—The Cumberland Plateau is a high table land, 2,000 feet in elevation, covering 5,000 square miles, and underlain with coals, shales, clays and limestones. At the northeast some mountains rise above the table land to about 3,000 or 4,000 feet, while numerous ravines and deep valleys cut into its otherwise flat top. It faces the



MARKET STREET, CHATTANOOGA.

Great Valley with a fairly even escarpment 1,000 feet high and generally precipitous. On the western side it forms a series of projecting headlands, inclosing rich coves. From either edge of the plateau wonderful views are to be had of the broad rich valleys to the east and west (as in the frontispiece).

• The plateau country is notable for its summer climate and many springs, which give rise to a large number of health resorts. The soil is a light sandy loam, usually thin, overlying a fine yellow or red clay silt



COKE OVENS, CUMBERLAND PLATEAU (Eastland, Tennessee).

subsoil. It is generally poor, and of small agricultural value, though areas of good fruit lands and lands adapted to potatoes and garden crops are abundant. It is believed the western headlands may prove highly suited to fruit raising when that is taken up as a business, rather than as a minor side issue. Lumbering and coal mining are the chief industries, and considerable bodies of virgin forests are still to be found away from the railroads. Probably one-half of the land is concentrated in large holdings for the coal and timber, or both. After the timber is cut many of these lands can be bought for one or two dollars an acre. In one case in the early part of 1911, a whole colony took up lands on the Plateau for close cultivation.



HIGHLAND RIM AND INCLOSED VALLEY.

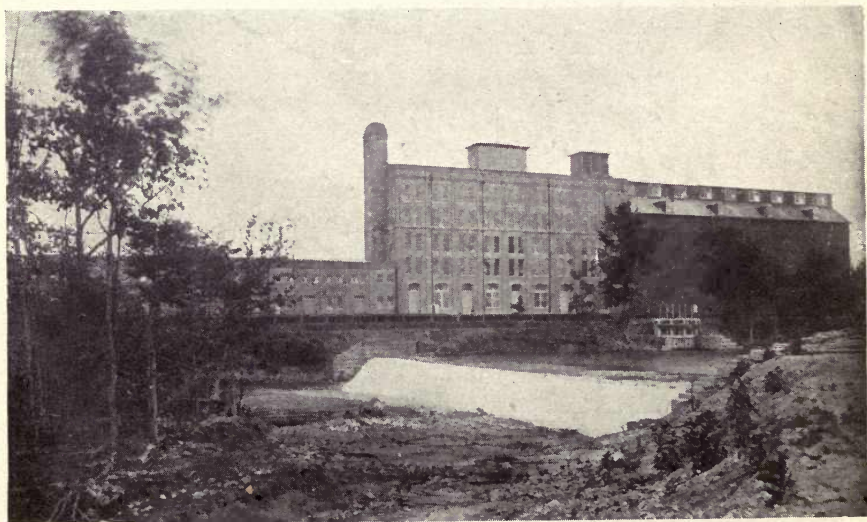
The Highland Rim.—The Highland Rim is a high, broad shelf, surrounding the Central or Nashville Basin, with an average elevation of 950 feet above sea level, and an area of 9,300 square miles. It is a rolling country with broad valleys and rounded hills. The underlying rock is chiefly limestone, though on the edge of the Rim, facing the Central Basin, the rock is mainly chert. The cherty lands while containing small areas of fairly productive soil, is, much of it, of varying and uncertain agricultural value. That much of it may some day prove suitable for the raising of fruit seems highly probable, judging by the success of one or two colonies that have settled on the ridges and started to raising small fruits. Much of the lands can now be obtained for a song, as the virgin forest has all been cut off. The limestone soils back from the rim are red and yellow clay loams, which are fertile and easily worked. They are especially adapted to tobacco, cotton, cereals and fruit. The chief indus-



LOGGING IN PERRY COUNTY.

try is agriculture, although lumbering and mining for phosphate and iron are also of local importance. There is little virgin timber left, and lumbering is usually on a small scale. The inner rim supplies chert and on the western side of the basin the "blue" phosphate rock just underlies the chert. From the outer edge of the rim will be supplied lithographic stone and building stone, fluorite, zinc, cement and other materials.

Nashville Basin.—The Central or Nashville Basin, with an area of 5,400 square miles, lies about 400 feet below the rim or about 500 feet above tide. It is a limestone basin. Much of the limestone of the western side is rich in phosphate, of which large quantities are now being mined. It is beautifully rolling, the hills rising from 50 to 150 feet above the adjoining valleys. It is one of the few regions of the world combining great agricultural richness, beautiful scenery, clear flowing streams and health conditions of the highest type, a region of wealth, culture and influence. Numerous railroads radiate from Nashville, affording, together with the Cumberland River, good means of transportation. The prin-



A COUNTRY FLOUR MILL, DAILY CAPACITY 2500 BBLs. OF FLOUR; 4000 BU. OF MEAL, ESTILL SPRINGS, TENN.



NASHVILLE BASIN WITH HIGHLAND RIM IN BACKGROUND.

cial wagon roads are macadamized, and with the exception of a few large estates, the land is held in small farms. The chief industry is agriculture. The soils in many places show the effect of continuous cropping for a hundred years or less without proper renewal, and in their depleted condition, close to the phosphate fields, offer splendid investments to any one willing to renew them by proper treatment. This area is natural blue grass land, and becoming famous for its fine cattle and sheep. The timber is largely confined to small ornamental groves about the houses, and to belts or patches of timber on broken lands along the creeks, and on the poorer hill sides and ridges.



CHARACTERISTIC VIEW IN WEST TENNESSEE.

West Tennessee Plateau and Bottom-Lands.—The plateau is a region of rolling upland with light fertile soils, sluggish streams, with swampy bottom, the uplands rising 200 to 400 feet above the stream bottoms. The reclamation of the stream bottoms has already begun. The region

is well supplied with railroads. It is the most densely populated part of the State, and is growing rich raising small fruits and vegetables for the early northern market.



WOODLOT ON UPLANDS, HARDEMAN COUNTY, TENNESSEE.

As the stream bottoms are brought under cultivation this region will become one of the garden spots of the United States. It is already the source of some of the best clays in the United States, and offers unusual opportunities for the manufacture of high grade clay products for the Southern market. Either side of the plateau are the valleys of the Tennessee River, with an area of 1,200 square miles, and the bottoms of the Mississippi River of nearly 1,000 square miles, both only awaiting reclamation to become what such river valleys as those all over the world become when properly reclaimed, the world's granaries. At present most of this area is covered with a

dense vegetation, spotted with lakes and marshes, and underlain with a soil of imperishable fertility.



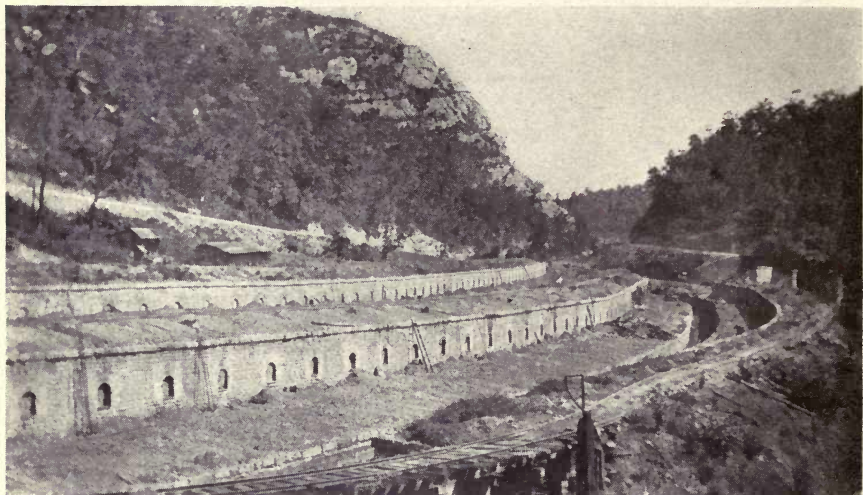
VILLAGE STREET, WEST TENNESSEE (Trenton).



MISSISSIPPI BOTTOM-LANDS, DYER COUNTY, TENNESSEE.

MINERAL RESOURCES

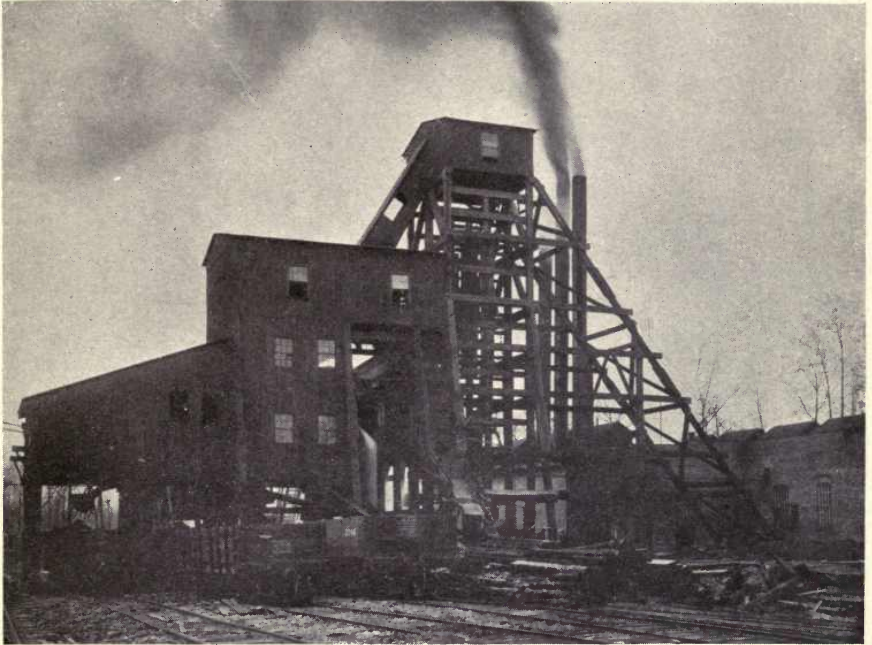
General Statement.—Between forty and fifty economic minerals are found in Tennessee in commercial quantities. The list includes among fuels—coal, oil, gas, and lignite; among metallic ores—those of gold, silver, copper, iron, lead, zinc, manganese, aluminum; among fertilizers—phosphate rocks and green sands or marls; among structural materials—granite, sandstone, limestone, marble, cement materials, chert, clays and kaolin and their products, sand and gravel, shale, slate, etc.; among materials used in the arts—barite, fluorspar, glass sand, gypsum, lithographic stone, metallic paints and mortar colors, pyrite, salt, sulphuric acid, etc.



COKE OVENS, LAFOLLETTE, TENNESSEE.

Not only has Tennessee a great variety of mineral resources, but most of them are in large quantities. Thus the United States Geological Survey estimates the coal of Tennessee at over 25,000,000,000 tons of which 90,000,000 tons have been mined; the iron of Tennessee at 500,000,000 tons; the phosphate rock at 100,000,000 tons; one of the marbles of the State outcrops in a series of belts 150 miles long. Zinc occurs in three belts, one of which is 40 miles long and from 50 to 700 feet wide. The State stands second in the production of barite and in the production of phosphate; third in the production of marble; sixth in the production of copper. Gold, silver, lead, oil and gas, fluorspar, manganese and pyrite occur in commercial quantities, though as far as yet found not in very large quantities. Most of the structural

materials listed occur in large quantities and of very high grade. There is hardly a single one of these industries that does not offer fine opportunities for investment and development. Many of the deposits have hardly been scratched, many are worked in a small way at a small profit, and only need large capital to make their development highly profitable.



COAL SHAFT, TIPPLE AND POWER HOUSE, BON AIR, TENNESSEE.

The occurrence of some of the principal mineral resources are described in the following paragraphs, taken alphabetically:

Barite or "heavy spar," used for a multitude of purposes, is widely scattered in vertical veins in the limestones of the East Tennessee Valley, the Central Basin and the Highland Rim. The principal producing counties have been Greene, Hamblen, Loudon, McMinn and Monroe, all in East Tennessee.

Bauxite, the common ore of aluminum, is being mined on the southeast slope of Missionary Ridge, near Chattanooga, by the National Bauxite Company.

Cement.—Pure limestones for cement occur in Tennessee in the flank of the Cumberland Plateau, where the white limestones are often several hundred feet thick. These are not always well situated for

quarrying, but many good quarry sites can be found. Certain limestones of the Great Valley and Central Basin are of high grade and abundant. In addition to the marble quarried in East Tennessee, which is a very pure limestone, other marbles over the State should prove suitable for making cement. Clays and shales are abundant in the coal measures of the Cumberland Plateau and in many places over the State. At the present time one mill alone is producing 600,000 barrels of Portland cement, worth half million dollars. Natural cement has been made from shaly limestones in Hardin and Knox counties, and many other counties contain limestones probably well suited to its manufacture.



CHERT ("GRAVEL") QUARRY, BENTON COUNTY, WEST TENNESSEE.

Chert for the use of roads and other purposes is abundant on the chert ridges of East Tennessee and around the rim of the Central Basin of Middle Tennessee, in the latter case forming a layer 200 feet thick. On the eastern edge of West Tennessee, the chert known as "novaculite," is extensively used for road making all over West Tennessee and to a slight extent in Middle Tennessee. It is possibly the best material for road building in the South.

Clays and Shales.—Aside from the surface clays used all over the State for the manufacture of brick, Tennessee possesses large quantities of high grade china clays and pottery clays. Ball clays, equal in every way to the English ball clays, and rapidly replacing their use, occur in a belt over West Tennessee, crossing Henry, Carroll, Henderson, Gibson, Madison, Hardeman and Fayette Counties. The clay occurs in lenses



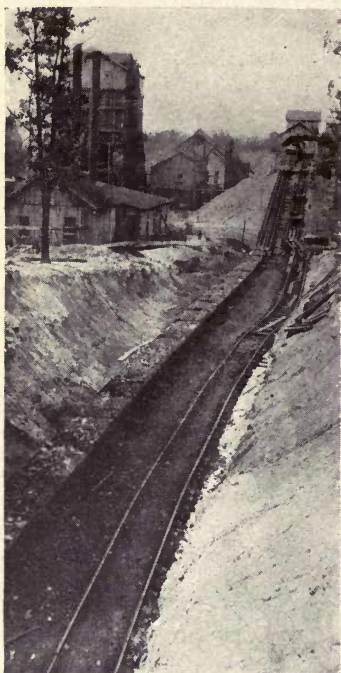
MINING BALL CLAY, HENRY COUNTY, TENNESSEE.

from 18 to 20 feet thick down to a feather-edge and over areas from one to two acres up to ten or twelve acres or more. Sagger, wad and fire clays are abundant in the same areas. These clays are being shipped to all of the States to the northeast. The other clays of the State have not yet been studied, but deposits of high grade are being worked here and there, and give much promise, especially in the plateau region.

As yet kaolin has only been found in small quantity, though recently a considerable deposit has been found near Sparta. Beds 18 inches thick are known to exist in Henry County, but under heavy cover.

Shales are abundant in the coal measures and in parts of the Great Valley, and are being utilized to some extent. Near Chattanooga a large industry has been built up, using the shales just below the coal measures, in making turpentine cups.

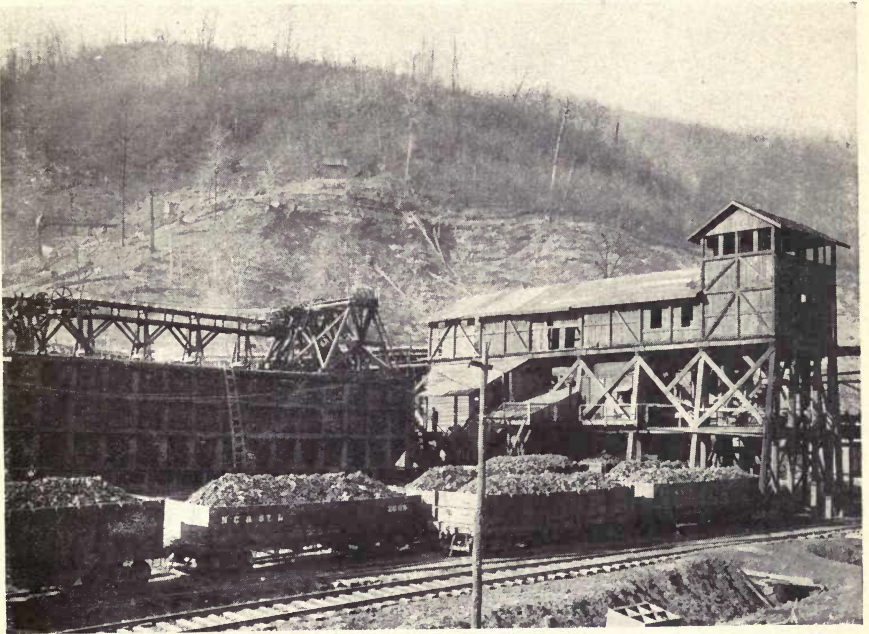
With high grade clays close at hand and all the needful materials, with cheap fuel and a growing market to the South and West, Tennessee offers an unusual field for the manufacture of high grade clay wares,—china ware, sanitary ware, electric insulators, etc. At the present time these clays are being shipped from Tennessee to East Liverpool, Ohio, and other places, made into chinaware, and shipped back to Tennessee or through the State to the Southeast.



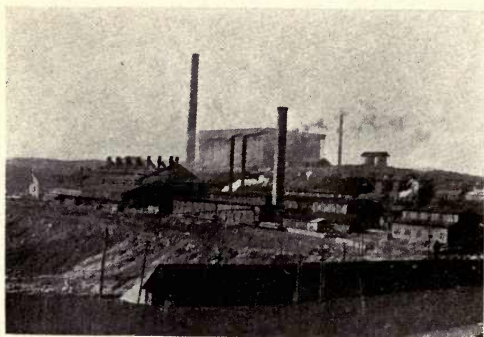
COAL MINE, TIPPLE AND WASHER,
EASTLAND, TENNESSEE.

Coal.—The coal field of Tennessee is coincident with the Cumberland Plateau, lying in a northeast-southwest direction a little east of the center of the State, and covering all or parts of twenty counties. The coal-bearing rocks have a thickness of 4,000 feet at the north end of the State, but as the rocks rise to the South, at the southern end of the State only a few hundred feet of the base of the measures remain capping the plateau. The lower 1,200 feet of the rocks are largely sandstones, and the coals associated with them are less regular than the higher coals, varying from 18 feet or more down to a fraction of a foot. Considerable areas of 3 or 4 foot coal are found, but in places the beds are thin and unworkable. The lower beds underlie the whole plateau, being found near its top at the south and along the western edge of the field, and dipping to the north and east so as to be mainly below the stream bottoms in the northeast part of the field.

The higher 3,000 or less feet of the rocks contain as many as 50 beds of coal, and while many of these are less than a foot thick, many of them are workable with a thickness of from 3 to 6 feet or more over large areas. Indeed, many of the more important beds can be traced from county to county and appear to be generally workable wherever they are under cover. Some of the beds are locally injured by partings of clay or shale that reduce the amount of merchantable coal. In Bryson Mountain, Claiborne County, a total thickness of coal was measured of 95 feet, of which 13 beds were of good workable thickness, and 7 were being worked in 1902-3. The worked beds showed an average thickness of from 4 to $6\frac{1}{2}$ feet, with a range of from $3\frac{1}{3}$ to $9\frac{2}{3}$ feet. The coals of Tennessee are of the bituminous variety and most of them will coke, yielding from 48 to 60 per cent. The coal of the Jellico field produces an indifferent coke, but has a wide reputation as a high grade household coal. The coals of the lower groups, as a rule, are cleaner, and harder than the higher coals.



TYPICAL COAL MINE, TENNESSEE.



GENERAL VIEW OF SMELTING WORKS AND ACID PLANT OF
TENNESSEE COPPER COMPANY.

Copper.—Tennessee's production of copper comes entirely from the region about Ducktown, in Polk County, in the extreme southeast corner of the State. The ores occur in a belt 2 miles wide by 4 miles long, lying in a north-east-southwest direction. They occur in fissure veins from a few feet to 150 feet wide in metamorphic schists. The ore, which is an iron ore, contains very near 10% of

copper ore, averaging about $3\frac{1}{2}\%$ of metallic copper. The ore is chiefly magnetic pyrite, with finely divided copper pyrite. The ore contains an average of about 31.4 pounds of copper per ton. In the weathered belt at the surface, the pyrrhotite has weathered into iron oxide, which is being used as a source of iron ore. (See illustration under iron.) The copper ores have been worked since 1843, and as early as 1855 a million dollars worth of ore was shipped. Recently expensive plants have been started at Ducktown to save the sulphur fumes formed in the reduction of the copper and convert them into sulphuric acid.

Dolomite.—The Knox Dolomite of East Tennessee, which covers many hundreds of square miles, has been very extensively used for abutments of railroad bridges and similar structural work. It is readily cut and dressed, and due to its firm, fine structure, is capable of standing great weight. It splits readily along bedding planes 6 inches to 3 feet apart and resists frost and heat well.

Fluorspar.—The fluorspar deposits of Tennessee have not yet been studied in detail. Small quantities of high grade rock coming from fissure veins, have been mined in Smith, Trousdale and Wilson counties. It is said that lumps of pure fluorspar weighing 1,500 pounds have been taken from these deposits. In some cases the fluorspar is associated with barite.

Glass Sand.—The white sandstone capping Chilhowee Mountain is now being crushed near Bristol and shipped north for making glass. Practically an endless amount of such sandstones exist in the State. Good sand is found at Coal Creek in Anderson County, and glass has been made in Knoxville from sand obtained on the opposite side of Holston River.

Gold has been found in Tennessee only along the eastern edge of the

State in Cambrian or Pre-Cambrian rocks on the western flank of the Great Smoky Mountains. Placer gold has been found in the creeks a few miles east of Montvale Springs, and back of Chilhowee Mountain in Blount County. In Polk County, gold is obtained as a by-product from the copper ores. In Monroe County on Citico Creek, Cane Creek, the headwaters of Tellico River, and on Coker Creek. The last locality has furnished about \$200,000 worth of gold, nearly all from stream gravels.

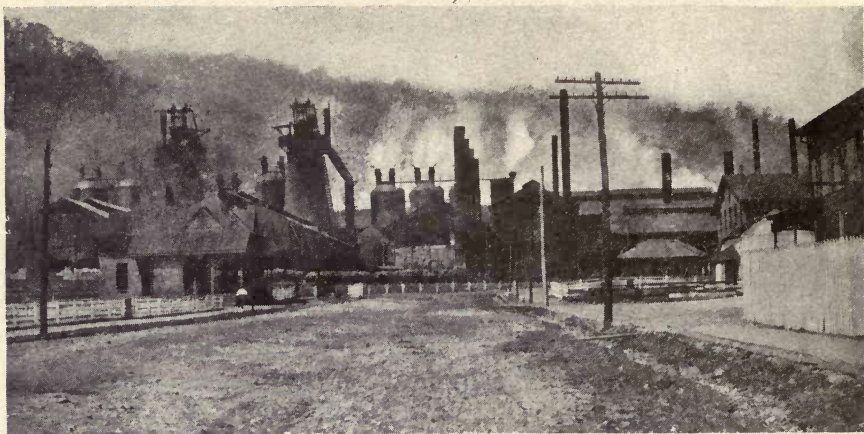
Granite in Tennessee is confined to the western slope of the Great Smoky Mountains. Portions of the Max-Patch granite, marked by red feld-spar, are very ornamental, as are the coarse grained masses in that granite. The Cranberry granite is lighter in color and fairly uniform in texture, and it is found in all of the counties along the eastern edge.

Green sand occurs in Western Tennessee, associated with the Selma Clays. Aside from lime and an appreciable amount of phosphorus, analyses show these green sands to often carry 10% or more of potash.



MINING IRON, DUCKTOWN, TENNESSEE.

Iron.—Tennessee ranks eighth in the production of iron, producing in 1907 nearly 1,000,000 tons. The ore occurs in four belts; first an eastern belt through Johnson, Sullivan, Carter, Washington, Unicoi, Greene, Cocke, Sevier, Blount, Monroe, McMinn and Polk counties, in which the ores are limonite, hematite and magnetite, occurring in irreg-



ROANE IRON WORKS, ROCKWOOD, TENNESSEE.

ular masses of limited extent, associated with the older rocks; second, a bed of red fossiliferous oölitic hematite, known as "Clinton ore." The ore occurs as a bedded deposit with much regularity, having a thickness of up to 6 feet. Where leached at the surface it will yield as high as 56% of iron, though the unweathered ore will yield much less. The ore occurs at the foot of the eastern escarpment of the Cumberland Plateau, and at many points east of that and into the lower part of the Sequatchie Valley. The third belt is co-ordinate with the coal field and the ore is of clay ironstone nodules in the shales of the coal measure rocks. The ore is usually not of high grade. The fourth belt covers over 5,000 square miles in western Tennessee. The ores are limonite with some hematite and turgite, and are associated with chert and clay from the decomposition of the St. Louis limestone. The deposits in places have a thickness of up to over 100 feet. The ore makes up from one-half to one-fourth or less of the mass. In 1908 there were 67 iron mines being worked by 38 companies, with 17 furnaces in active operation, all but one using coke for fuel.

Lead ore has been found in true veins in grains and lumps in Union County, and disseminated in grains through the rocks of Bumpus Cove in Washington County, and as irregular masses or benches in McMinn County. Veins are known in Monroe, Bradley and Jefferson counties, all of which have been worked. Many veins have been found and opened in the Central Basin, including mines in Davidson County and Williamson County near Nolensville. Fine specimens have been found in Hickman, Henry and other counties. Lead has been mined with zinc on Straight Creek in Claiborne County, and is found in minable quantities in Blount County and in Bradley County. It has been mined

for some years at Blue Springs 6 miles south of Cleveland, and at the Cedar Ridge mine encouraging prospects have been found. Ores are the sulphide, except where weathered into the lead carbonate. In 1906 over 200,000 pounds were mined.

Lignite, or brown coal, is found extensively in the Eocene deposits of West Tennessee. The beds are interstratified with clay and sand and vary from a few inches up to 4 or 5 feet in thickness. Beds have been found extensively in Obion, Dyer, Lauderdale, Tipton and Shelby counties along the escarpment of the Mississippi bottoms. Attempts to use this lignite in the past have not been successful.



LIME KILNS, SHERWOOD, TENNESSEE.

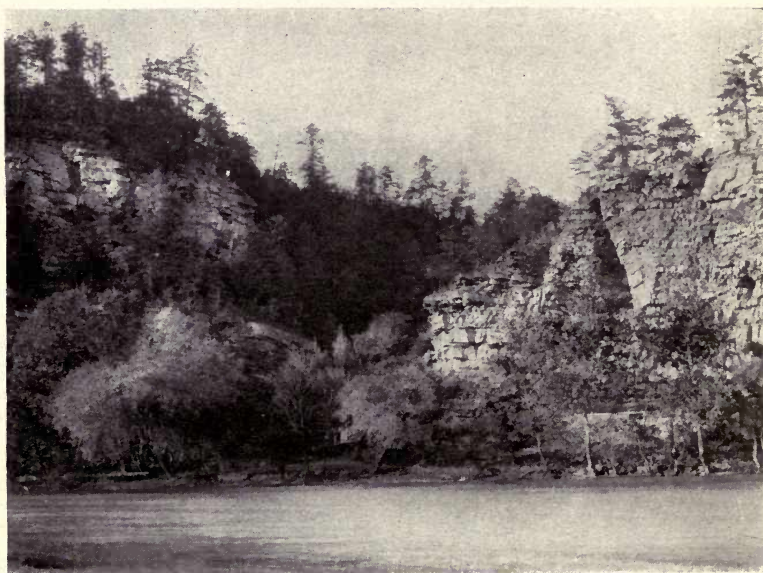
Limestones form probably a majority of the rocks of the State. They are in every shade of color from gray to black, and every variety from pure, heavy bedded limestone to very impure, laminated, shaly or sandy limestones, that soon crumble when exposed to the weather. They are put to a variety of uses from building roads to lining fine buildings. Somewhat less than 1,000,000 tons valued at half a million dollars were mined in 1908 (not including marble).

Lithographic stone has been found near Algood in Putnam County. The limestones occurring a short distance below the base of the coal measures all along the western escarpment of the Cumberland Plateau tend to contain limestones of lithographic character, but as a rule, not free enough from imperfections to serve as commercial stone.

Manganese in the form of oxides, occurs in northeastern Tennessee, notably in Shady Valley, Johnson County; near Unicoi, Unicoi County; near Newport and Del Rio, in Cocke County. The ores occur in the lower part of the Shady limestone in variegated clays as hard nodules or irregular masses, generally associated with brown iron ores. The ore also occurs near Morristown, Hamblen County; near Sweetwater, Monroe County, and elsewhere.



LIMESTONE QUARRY, SHERWOOD, TENNESSEE.



CLIFF OF MARBLE, TENNESSEE RIVER (near Knoxville.)



A CORNER IN A MARBLE QUARRY, KNOXVILLE.

Marble.—Tennessee has long been famous for her marble, which is extensively quarried in a broad belt running northeast and southwest from Knoxville. Three-fourths of a million dollars worth was quarried in 1908, coming mostly from Knox and Blount counties. The bulk of the stone is used for interior decoration, for which it is highly suited. The main marble stratum has a thickness of from 300 feet up to 650 feet, though usually not over 50 feet is workable at any one point. The marble varies in color from cream, yellow, brown, chocolate and red, to pink or blue in endless varieties. Tests show it to have a

high chemical purity and high crushing strength and high resistance to absorption of water. A large variety of marbles occur well distributed over the State.

Metallic Paints and Mortar Colors are obtained from low grade ores or in some cases from high grade ores where not mined for metal. The oxides and carbonates of iron, zinc and lead, are so used, the supply coming mainly from Bradley, Cheatham and James counties.

Mineral Springs are abundant in Tennessee, and in most cases have adjacent to them hotel accommodations of greater or less pretensions. In addition, in 1908, \$60,000 worth of spring water was sold.

Oil and Gas have not as yet proved very profitable in Tennessee. In a number of areas those substances have been encountered in wells, and, all told, many thousand barrels have been secured and sold. Apparently most of the oil and gas have come from rocks, either closely above or below the Chattanooga black shale, so that the greatest development and most promising field consists of a belt around the Highland Rim, where the Chattanooga black shale is usually less than 300 feet under cover. Considerable quantities of oil have been obtained from wells less than 100 feet deep. In fact most of the oil in the State, as in the corresponding parts of Kentucky, has been obtained from these very shallow wells. The best wells have been found in Overton, Fentress, Scott and Putnam counties. The oil is of high grade, free from sulphur, of 38.60° to 43.60°

Baumé. Some of the oil has been hauled to the Cumberland River or to McMinnville for shipping or run into tanks, and for a time a pipe line was extended into the State, but the production in that part of the field was not maintained, and the pipe line was taken up. Some oil and gas have been found on the western side of the Central Basin, associated with the black shale. Some drilling is in progress at present near Memphis in the rocks of Tertiary and Cretaceous age, but as yet no oil has been struck.

Phosphate.—Tennessee ranks next to Florida in the production of phosphate, producing in 1907, 638,612 longtons, valued at \$3,047,836. Four main types of phosphate rock are found: The "brown" resulting from the leaching of a number of limestones of Trenton age. The original limestones contain bands, running from 30 to 55 per cent of lime phosphate, which, when weathered, will leach to a porous brown rock, resembling sandstone, and containing from 70 to 82 per cent of bone phosphate. The brown phosphates occur as surface deposits from 3 to 12 feet thick, averaging about 6 feet. The second type known as the blue or gray phosphate is a bedded deposit at the base of the Chattanooga black shale. It has a thickness of from 4 feet down, and as a rule is mined in the same way as coal. It is widely distributed all around the Central Basin.

Immediately above the black shale is a green shale, containing nodules of phosphate, carrying up to 69 per cent of lime phosphate. In Decatur and Perry counties appear white phosphates, that seem to be recrystallized calcium phosphate, as though one of the earlier phosphatic beds had been dissolved and redeposited. The brown phosphates are confined to a wide area in the western, northern and southern parts of the Central Basin, while the blue phosphates occur in the escarpment of the Highland Rim all about that basin.

Pyrite, while largely scattered through the rocks all over the State, has been worked on Stony Creek, in Carter County, 12 miles northeast of Elizabethton. Large quantities have been found in Moore, Cheatham and Greene counties, as well as in association with the copper ores of Polk County.

Sandstone abounds in the Cumberland Plateau where certain massive beds are mainly responsible for the flat character of the plateau. Considerable building stone has been quarried from this plateau sandstone which has been used locally in buildings, and to some extent shipped to Nashville and elsewhere. In East Tennessee many of the ridges are made up of hard sandstones, too often too hard to work with ease.

Silica Rock, so called, is being mined at several points and ground for use as polishing powder. As a rule these rocks are composed of decayed chert. A plant of this kind exists at Black Fox, in Bradley County, and another near Bristol, is grinding a pure sandstone to flour.

Silver production in Tennessee has been confined to that obtained as a by-product in the mining of the copper ores in the Ducktown region. Numerous stories of silver mines are found over the State, but so far the silver has not materialized.

Slate occurs abundantly in the extreme eastern counties. During the last year some of it has been mined on a commercial scale. The slate is a pale green semi-talcoose variety, very durable when free from pyrite, and splitting readily into plates with smooth surfaces. The slate has the necessary hardness, evenness, and cleavage along the Little Pigeon River, and is well exposed over large areas. Quarries have been opened in it at many points for local use. The slates are found in Cocke, Sevier, Blount, Monroe, McMinn and Polk counties.



ZINC MINE AT LEAD MINE BEND.

Zinc mining in Tennessee is still in the development stage. The ores are confined mainly to the magnesian limestones or dolomites and principally to three belts in the Great Valley. The first belt crosses Claiborne and Union counties, near New Prospect, 6 miles southeast of Tazewell. The second belt follows the Southern Railway along the Valley of the Holston River for 40 miles, having a width of from 50 to 700 feet. The third belt lies further south near the French Broad River. The main ore is zinc blend, weathering to the carbonate at the surface.

As a rule, the ores are of low grade, though bringing a good price because free from iron. They appear closely associated with fault zones where the rocks have been broken over a wide belt. One difficulty experienced in smelting the zinc has been its association with barite.



UNUSED WATER-POWER IN TENNESSEE.

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(Figures refer to pages; a, b, c to 1st, 2d and 3d cut on page.)

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PUBLICATIONS OF THE STATE GEOLOGICAL SURVEY

The following list shows the publications issued by the State Geological Survey or in preparation at the time this bulletin goes to press, April, 1911. Except for five hundred copies of each publication (which are reserved for sale at the cost of printing), the bulletins will be sent free on request, accompanied by stamps, made to the State Geologist, Capitol Annex, Nashville, Tennessee.

Bulletins Nos. 1-A, 1-B, 2-A, 2-D, 2-E, 2-G, 3, 4, 5, 9-A and 13, issued.

Bulletin No. 1.—Geological work in Tennessee. (Parts A and B issued).

- A. The establishment, purpose, object and methods of the State Geological Survey; by Geo. H. Ashley; 33 pages; issued July, 1910; postage, 2 cents.
- B. Bibliography of Tennessee and related subjects; by Elizabeth Cockrill. Issued; postage, 3 cents.
- C. History of Geological work in Tennessee; by L. C. Glenn, (in preparation.)

Bulletin No. 2.—Preliminary papers on the Mineral Resources of Tennessee; by Geo. H. Ashley and others. (Parts A, D, E and G issued).

- A. Outline introduction to the Mineral Resources of Tennessee; by Geo. H. Ashley. Issued September 10, 1910; postage, 2 cents.
- B. The Coal Fields of Tennessee; by Geo. H. Ashley, (in preparation).
- C. The Iron Ores of Tennessee; by R. P. Jarvis, (in preparation).
- D. The Marble of East Tennessee; by C. H. Gordon. Issued; postage, 2 cents.
- E. Oil and Gas Development in Tennessee; by M. J. Munn. Issued; postage, 2 cents.
- F. The Phosphate Deposits of Tennessee; by Lucius P. Brown, (in preparation).
- G. Zinc Mining in Tennessee; by S. W. Osgood. Issued; postage, 1 cent.
- H. Preliminary Geological map of Tennessee, (in preparation).

Bulletin No. 3. Drainage Reclamation in Tennessee; 74 pages, issued July, 1910; postage, 3 cents.

- A. Drainage Problems in Tennessee; by Geo. H. Ashley; pp. 1-15; postage, 1 cent.
- B. Drainage of Rivers in Gibson County, Tennessee; by A. E. Morgan and S. H. McCrory; pp. 17-43; postage, 1 cent.
- C. The Drainage Law of Tennessee; pp. 54-74; postage, 1 cent.

Bulletin No. 4. Administrative Report of the State Geologist for 1910. Issued; postage, 2 cents.

Bulletin No. 5. Clay Deposits of West Tennessee; by Wilbur A. Nelson. Issued; postage, 3 cents.

Bulletin No. 6. Road Building in Tennessee; by Geo. H. Ashley, (in preparation).

Bulletin No. 7. Water Resources of Tennessee; by L. C. Glenn, (in preparation).

Bulletin No. 8.—Economic Geology of the Dayton-Pikeville Region; by W. C. Phalen, (in preparation).

Bulletin No. 9.—Studies of the Forests of Tennessee.

A. An investigation of the forest conditions in Tennessee; by R. Clifford Hall. Issued; postage, 2 cents.

B. A study of the growth of the second growth hardwoods; by W. W. Ashe, (in preparation).

Bulletin No. 10.—The marbles of East Tennessee, illustrated with colored plates; by C. H. Gordon, (in preparation).

Bulletin No. 12.—The undeveloped small water powers of Tennessee; by J. A. Switzer and Geo. H. Ashley, (in press).

Bulletin No. 13.—The Resources of Tennessee, (a brief summary); by Geo. H. Ashley. Issued; postage, 2 cents.



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